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METHOD OF OPERATION

Schematic - Test And Sender Circuits - Outgoing Trunk Test Board - Machine Switching System.

SOUTHWESTERN BELL TELEPHONE COMPANY
MAIN OFFICE - KANSAS CITY MISSOURI

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GENERAL DESCRIPTION

1. This circuit is a sender and test cord combined. It is used to test trunk circuits outgoing to a relay call indicator office, a tandem relay call indicator office or a mechanical office. Three sequence switches are provided in this circuit, namely, cord switch, (R-1) sender switch (R-2) and impulser switch (R-3).

MECHANICAL CALLS.

2. When the plug of the test cord is inserted in a non busy outgoing trunk jack to a mechanical office and the test number is set up on the recording keys, with the full mechanical FM start key depressed the trunk is made busy to all hunting selectors and selection begins. If the plug of the cord is inserted in the jack of a busy trunk the red lamp lights and the recording keys are ineffective. The green lamp flashes during selection. If the red lamp is lighted after the green lamp has started to flash, it is an indication that the incoming or final circuits have gone to tell-tale. Should the start key be held operated, and if after selection is completed the TEST key in the associated voltmeter test cord circuit is also operated, the trunk under test is connected through to the voltmeter circuit. If the start key is not held operated, at the time trunk closure takes place the associated incoming circuit goes to ringing position and the green lamp signal is changed from a flashing to a steady one.

3. With the circuit closed through in talking position, the white lamp is under control of the switchhook at the called station. The circuit may be restored to normal as soon as the ringing signal is received by removing the plug of the test cord from the associated trunk jack, or it may be restored at any stage of the circuit process by the operation of the disconnect key.

CALL INDICATOR AND TANDEM INDICATOR CALLS

4. These classes of calls are handled in a manner similar to that described for "Mechanical Calls" with the following exceptions. (a) The plug of the cord is inserted in the outgoing trunk jacks of the relay call indicator and tandem call indicator trunks in place of the full mechanical trunks and the TAN and RCI keys are operated in place of the FM key. In the case of a tandem indicator call, the operator depresses the proper tandem tens and tandem units keys depending on the office called.

DETAILED DESCRIPTION

OPERATION

SEMI-MECHANICAL CALLS

5. With the plug of the cord inserted in the test jack of a non busy outgoing trunk jack, the operation of the full mechanical start key FM operates the FM and MB relays in series. The FM relay operated locks in series with the MB relay under control of cam G of the cord sequence switch and the TK relay. The operation of the MB relay connects ground on its make contact to the sleeve of the cord thus making the trunk busy to all hunting districts selectors. The MB relay operated also advances the sender switch (R-2 from position 1 to position 4 in a circuit from ground on the armature of the MB relay, both upper contacts of cam H, break contact of CC relay both outer contacts of cam D, break contact of the CI relay, make contact of the FM relay, lower outer contact of cam B to battery through R magnet of the sender switch (R-2). With the sender switch in position 4, the above circuit closure is extended through both lower contacts of cam C of the sender switch and upper inner contact of cam B of the cord switch (R-1) advancing the cord switch from position 1 to position 2. The green lamp flashes in this position as an indication that selection is taking place. With the cord switch in position 2 and the sender switch in position 4, the TG relay and FM resistance are bridged across the tip and ring of the cord. On full mechanical calls, the TG relay will be operated by battery and ground from the incoming trunk circuit at the distant office. The TG relay operated operates the TK relay, which in turn advances the sender switch to position 5. The TG and TK relays release when the sender switch leaves position 4.

6. With the sender switch in position 5 and the cord switch in position 2, the fundamental circuit is closed over the tip and ring of the trunk for operating the STP relay for incoming brush selection. The path being from the distant office over the ring of the trunk and the ring of the cord, through both lower contacts of cam N, of the cord switch, 35 ohm winding of OFL relay which is differentially wound and therefore will not operate with the normal flow of the current, both windings of STP relay, break contact of BO' relay, both inner contacts of cam N of the sender switch, upper outer and lower inner contacts of cam M, of the cord switch tip of the cord and tip of the trunk to the distant office. The selection of the incoming brush at the distant office is controlled by the number of counting relays set, which in turn are determined by the thousandths key operated, The associated incoming circuit at the distant office advances to its brush selection position, and by means of its A commutator brush and segment, successively short circuits and permits the re-operation of the STP relay. Upon each operation and release of the STP relay, one set of counting relays is operated and locked. The circuit for operating the counting relays is traced from battery through contacts of cams J and 1 of

the sender switch the winding of counting relay #3, assuming that the incoming brush 4 is to be selected, break contact of counting relay #3' to lead 3, which is connected by strapping to all terminals designated 3 at the right of the thousands keys. (To select #4 incoming brush it is necessary that thousandths key #6 or #7 be operated), inner right make contact of thousandths key operated, upper inner and lower outer contacts of cam H, make contact of STP relay, to ground on cam K, operating the #3 counting relay. With the #3 counting relay operated, ground on its armature is connected to the winding of the #3' counting relay, which does not operate at this time, due to the ground connected to the other side of its winding through the contact of the STP relay. When the A commutator brush in the associated incoming selector at the distant office makes contact with the first "A" commutator segment, the STP relay short circuited and released, disconnecting ground from one side of the winding of the counting relay #3', allowing it to operate and lock in series with the #3 relay to battery on cam J. The #3' relay operated transfers the pulsing circuit through its armature and make contact to the #2 set of counting relays, ready for the next pulse. The #2 and #1 and #0 sets of counting relays are similarly operated on the second, third and fourth pulses respectively, applied to the fundamental circuit.

7. When the STP relay releases on the fourth impulse, the BO' and FO' relays in parallel and in series with the O relay look over a circuit from battery through the O relay, to ground on the armature of the O counting relay. The operation of the BO' relay opens the fundamental circuit thus completing brush selection. The FO relay operated closes a circuit from ground on cam L, to battery through the R magnet of the sender switch, advancing the sender switch to position 7.

8. The function of the circuit through the K and H cams is to reverse the contact polarity of the stepping relay for each succeeding selection to prolong the life of the relay contacts.

9. With the sender switch in position 7, incoming group selection takes place in a manner similar to incoming brush selection. The incoming group selection depends upon the closure of the thousandths key in combination with the hundredths key (assuming that the number called is 6543). The IG relay is operated by ground on the right make contact of key 5 in the hundredths row. The circuit for operating the counting relay is traced from ground on cam K, through the left inner make contact of thousandths key #6, make contact of IG relay over lead #1 to the #1 counting relay which functions as previously described, When the FO' relay is operated, the switch is advanced to position 9.

Final brush, tens, and units selection.

10. With the sender switch in position 9, 11 and 13 final brush tens and units selection take place. The circuit operating the counting relays is traced in these cases from cam K, through left make contact of Hundredths key 5 to the O counting

relay, through TENS key 4 to the #4 counting relay and from UNITS key 3 to the #3 counting relay.

11. In position 15, the sender circuit closure is made for the purpose of advancing the final and the incoming circuits. Reverse battery is connected back over the fundamental circuit by the incoming circuit operating the OFL and the STP relays in series. With these relays operated the O relay is operated over a circuit from ground on the armature of the OFL relay, lower inner and upper contacts of cam M, make contact of STP relay, upper outer and lower inner contacts of cam H, through the winding of the O relay to battery on cam 1. With the O relay operated the FO' relay is again operated and advances the sender switch to position 16. With the sender switch in position 16, the CC relay is operated over a circuit from battery through its winding, both inner contacts of cam E, to ground through the lower inner contact of cam L of the sender switch. The CC relay operated advances the cord switch to position 3 over a circuit from ground on the armature of the TK relay (normal), lower outer and upper inner contacts of cam H, make contact of the CC relay, upper outer contact of cam C to battery through the R magnet. With the cord switch in position 3, the green light is extinguished. If the start key is held in the operated position, the MB relay is held operated thus preventing the cord switch from advancing. When the test key in the voltmeter cord circuit (not shown) is operated, the VM relay operates advancing the cord switch to position 7. The outgoing trunk under this condition is closed through to the voltmeter circuit for testing. When the voltmeter test is not required the MB relay is released by the release of the start key and ground on its armature advances the cord switch from position 3 to position 4, and the A cam carrying the switch to position 5. With the cord switch in positions 4 to 6 inclusive, the green lamp burns steadily as a ringing signal. With the cord switch in position 3 to 7 inclusive, the TC and S relays in series are bridged across the tip and ring of the trunk. The TC relay is operated by battery and ground over the fundamental circuit due to trunk closure but the S relay which is polarized will not operate until the current is reversed which is caused by the call being answered at the distant office. In positions 3 to 5 the CC relay is operated in a circuit from battery through its winding, lower inner and upper outer contacts of cam E, make contact of the TC relay, to ground on the armature of the VM relay. Should the test cord be removed from the test jack, when the ringing signal is received in position 4 and before the switch reaches position 6 the CC relay will be held operated over a circuit from battery through its winding, both inner contacts of cam D, break contact of TC relay, to ground on the armature of the VM relay. In either case the CC relay operated advances the cord switch from position 5 to position 6 over a circuit from ground on the armature of the TK relay, through the lower outer and upper inner contacts of cam H, make contact of the CC relay, upper contact of cam C, to battery through the R magnet. The cord sequence switch is advanced from position 6 to position 7 by the release of the CC relay. The CC relay is released either by the S relay operating due to trunk line reversal when the call is answered at the distant office or by the cord being removed from the outgoing trunk jack,

releasing the TC relay. The CC relay released, advances the cord switch to position 7 in a circuit from ground on the armature and break contact of the TK relay through lower outer and upper inner contacts of cam H, break contact of CC relay, lower outer contact of cam C, to battery through the R magnet. In position 7, the talking circuit is closed between the test board and the line called, and the white supervisory signal is under control of the S relay which in turn is controlled over a circuit from the distant office. The VM relay is operated by the operation of the test key in the associated voltmeter test cord circuit, connecting the test cord through to the voltmeter test circuit for testing.

12. With the cord switch in position 7 or 8 and with the test cord removed from the jack, the CC relay is operated in a circuit from ground on the armature of the VM relay, break contact of TC relay, both inner contacts of cam D to battery through its winding, advancing the cord switch to position 9, in a circuit to ground on the armature of the TK relay.

13. All three of the sequence switches are restored to normal from ground on the armature and break contact of the TK relay. With the cord switch in position 4 to 9 inclusive, ground on the armature of the TK relay is connected through both lower contacts of cam H, to cam C of the impulse switch. This ground on cam C will advance the impulse switch from either off-normal positions (13 or 18) to normal position (1). With the impulse switch in position 1, the same ground, through cam C advances the sender switch to normal from any off-normal position, by the way of the lower inner contact of cam B of the sender switch. With the sender switch in position 1 and the cord switch in position 9, the same ground through cam C advances the cord switch to normal position, by the way of both outer contacts of cam P of the sender switch and the upper outer contact of cam B of the cord switch.

14. At any stage of the circuit process, the disconnect key if operated will advance the cord sequence switch into position 9 awaiting re-set.

15. When the plug of the test cord is inserted in a jack of a busy outgoing trunk, the TK relay is operated by ground on the sleeve of the busy trunk jack. The TK relay operated lights the red lamp as a busy signal and opens the circuit in which the MB and associated relays are operated thus making the start keys ineffective.

TELL TALE

16. In mechanical calls if the incoming selector or final selectors go to tell tale, the OFL relay will be operated by reverse battery and ground from the incoming circuit. In this case the windings of the OFL relay, are connected series aiding. The OFL relay operated operates the TK relay, in turn lighting the red lamp in a circuit, from ground on the armature of the TK relay, both lower contacts

of cam K of the cord switch, both upper contacts of cam D of the sender switch to battery through the red lamp.

OVERFLOW

17. With the sender switch in position 9 and the cord switch in position 2, if the incoming circuit goes to overflow it reverses battery and ground over the fundamental circuit, operating the OFL relay. With the OFL relay operated, the TK relay operates and locks under the control of cam J of the cord switch, and cam L of the sender switch. With the TK relay operated, the cord switch is advanced from position 2 to position 8, where the white lamp flashes as an overflow signal. The circuit in which the cord switch is advanced is traced from ground on the armature of the TK relay, through both lower contacts of cam K, both inner contacts of cam D to battery through the R magnet of the cord switch.

RELAY CALL INDICATOR CALLS

18. On calls of this class, the circuit functions in a manner similar to that described for "Mechanical Calls" with the following exceptions. The start key RCI is depressed in place of the FM key and the CI relay operates in series with the MB relay in place of the FM relay. The impulser switch if off normal is advanced to position 1 over a circuit from ground on the armature and make contact of the MB relay, both upper contacts of cam H, break contact of CC relay, both outer contacts of cam D of the test cord switch, make contact of the CI relay, break contact TA relay, both lower contacts of cam E of the sender switch, lower inner contact of cam B of the impulser switch to battery through the R magnet. The sender switch is advanced from position 1 to position 2, by the circuit closure previously described, extended through both inner contacts of cam D of the impulser switch and the upper outer contact of cam B of the sender switch to battery through the R magnet. With the sender switch in position 2 the cord switch is advanced from position 1 to position 2 by the same circuit closure extended through the upper outer and lower inner contacts of cam C of the sender switch and upper inner contact of cam B of the cord switch to battery through the R magnet. With both the sender and cord switches in position 2, the TG relay is bridged across the tip and ring of the cord for the purpose of lighting the guard lamp in the call indicator circuit (not shown) and for preparing the sender for the call indicator impulse transmission. The TG relay is battery by battery and ground from the call indicator circuit (not shown) in turn operating the TK relay. The TK relay operated locks in a local circuit to ground on the L cam closing a circuit through both lower contacts of cam K of the cord switch and the upper inner contact of cam B advancing the sender switch from position 2 to position 3. With the sender switch in position 3 the TK relay is held operated to ground on the armature of the TG relay and the holding circuit for the TG relay is transferred through the contact of the TK relays. When the circuit

is opened by the operation of the assignment key in the call indicator trunk circuit (not shown) the TG relay releases in turn releasing the TK relay. With the sender switch in position 3, the cord switch in position 2, and the TK relay released, a circuit is closed advancing the impulser switch through one revolution. This circuit is traced from ground on the armature and break contact of the TK relay, lower outer and upper inner contacts of cam H, break contact of CC relay, both outer contacts of cam D, make contact of CI relay, break contact of TA relay, lower inner and upper outer contacts of cam E of the sender switch, lower outer contact of cam B of the impulser switch to battery through the R magnet. While the impulser switch is advancing through one revolution, impulses of positive and negative battery and ground are sent over either the tip or ring of the trunk to the distant office through either high resistance (3500) or low resistance (52.5 ohms) in accordance with the recording keys depressed. This causes certain relays at the distant office to operate and lock, displaying the number corresponding to the keys operated. The stepping and counting relays are not used in sending calls to relay call indicator offices. With the impulser switch between positions 16 and 18 inclusive, a circuit is closed in which the CC relay operates. This circuit is traced from battery through the CC relay, both inner contacts of cam E of the cord switch, both inner contacts of cam K of the impulser switch, break contact of TAN relay, both outer contacts of cam Q of the sender switch, to ground through the lower inner contact of cam G of the impulser switch. The CC relay operated advances the cord switch from position 2 to position 3 from ground through the back contact of the TK relay. From this point on the circuit functions as previously described under "Mechanical Call".

TANDEM CALL INDICATOR

19. On calls of this class, the circuit functions in a manner similar to that described for the non-tandem calls excepting that the tandem recording keys are brought into play, and the impulser switch is governed so that it transmits tandem impulses followed by regular impulses. The TAN key depressed operates the TA relay in a circuit from battery through the relay, make contact of the TAN key, lower inner and upper outer contacts of cam G of the cord switch to ground on the armature of the TK relay. With the TA relay operated, the CI and MB relays operate in series and lock as previously described through the make contact of the CI relay. The TA and MB relays operated advances the impulser switch from position 1 to position 13. This circuit is traced from ground on the armature of the MB relay, both upper contacts of cam H, break contact of CC relay, both outer contacts of cam D of the cord switch, make contacts of CI and TA relays, lower inner and upper outer contacts of cam F of the sender switch, upper inner contact of cam B of the impulser switch to battery through the R magnet. With the impulser switch in position 13, the TAN relay is operated by the circuit closure previously described, extended through both outer contacts of cam D as the impulser switch to battery through the winding of the TAN relay. With the impulser switch in position

13, the sender switch is advanced from position 1 to position 2 in a circuit from ground through the lower outer contacts of cam G of the impulser switch, make contact of the TA relay, upper outer contact of cam B of the sender switch to battery through the R magnet. With the sender switch in position 2 this circuit closure is extended through the upper outer and lower inner contacts of cam C of the sender switch and upper inner contact of cam B of the cord switch to battery through the R magnet, advancing the cord switch from position 1 to position 2. The TG and TK relays function as previously described on a direct call indicator call the sender switch advancing to position 3. With the sender switch in position 2 and 3, the TAN relay is locked under control of cam Q of the sender switch and cam G of the impulser switch. When the TG relay releases in turn releasing the TK relay following the depression of the assignment key at the distant office, the impulser switch advances from position 13, through position 18 and through position 13 again of the second revolution, in a circuit from ground through armature and break contact of TK relay, lower outer and upper inner contacts of cam H, break contact of CC relay, both outer contacts of cam D, make contacts of the CI and TA relays, both lower contacts of cam F, upper outer contact of cam B to battery through the R magnet. When the impulser switch has passed position 3 of the second revolution, the TAN relay is released, by its locking circuit being opened at cam G of the impulser switch. With the impulser switch in position 16 to 18, the sender switch in position 3 and the TAN relay released, the CC relay is operated and advances the cord switch to position 3. The circuit in which the CC relay is operated is traced from battery through the relay, both inner contacts of cam E of the cord switch, both inner contacts of cam K of the impulser switch, break contact of TAN relay, both outer contacts of cam Q of the sender switch, to ground through lower inner contact of cam G of the impulser switch. The revolution of the impulser switch from position 13 of the first revolution to position 16 of the second revolution transmits the tandem tens, tandem units, stations, thousandths, hundredths, tens and units in the order as given, to the distant office. From this point on the circuit functions as previously described.

CIRCUIT REQUIREMENTS

	OPERATE	NON-OPERATE	RELEASE
B60 (TC)	Test .0034 amp. Readj. .0032 amp.	Test .0022 amp. Readj. .0024 amp.	
B142 (TG)	Test .0045 amp. Readj. .0042 amp.	Test .0031 amp. Readj. .0033 amp.	
B143 (OFL) Primary & Tertiary in Mult.	Test .032 amp. Readj. .030 amp.	Test .021 amp. Readj. .023 amp.	
Secondary		On 50 volts.	
Spl. E34 D-20624 Coded E414 (MB)	Test .023 amp. Readj. .017 amp.	Test .010 amp. Readj. .011 amp.	
Spl. E106 D-22092 Coded E635 (VM)	Test .019 amp. Readj. .016 amp.	Test .0085 amp. Readj. .009 amp.	
Spl. E106 D-[illegible] Coded E566 (TAN)	Test .019 amp. Readj. .016 amp.	Test .0085 amp. Readj. .009 amp.	
Spl. E197 D-20255 E572 (IG)	Test .019 amp. Readj. .016 amp.	Test .0095 amp. Readj. .010 amp.	

CIRCUIT REQUIREMENTS

	OPERATE	NON-OPERATE	RELEASE
Spl. E265 D-20325 Coded E623 (TA)	Test .018 amp. Readj. .014 amp.	Test .0065 amp. Readj. .007 amp.	
Spl. E106 D-22092 Coded E635 (TK)	Test .019 amp. Readj. .016 amp.	Test .0085 amp. Readj. .009 amp.	
Spl. E24 D-22077 Coded E640 (CC)	Test .0088 amp. Readj. .0083 amp.	Test .0055 amp. Readj. .0058 amp.	
Spl. E18 D-20063 Coded E643 (CI & FM)	Test .020 amp. Readj. .012 amp.	Test .0075 amp. Readj. .008 amp.	
#203-A (S)	When positive battery is connected to the positive terminal of the relay. Test .003 amp. Readj. .0025 amp.		On open circuit.
#207-A (STP) Armature air gap .013" to .014" contact air gap .003" to .004"	Test .010 amp. Readj. .0098 amp.	Test .009 amp. Readj. .0092 amp.	
#208 D-20782 Coded #208-G counting relays 0 to 9 armature gap .018" to .021" Contact gap .004" to .005"	Test .0152 amp. Readj. .0148 amp.	Test .0138 amp. Readj. .0142 amp.	

CIRCUIT REQUIREMENTS

	OPERATE	NON-OPERATE	RELEASE
#208-B counting relays 1 to 9 Armature Gap .018" to .021" Contact Gap .004" to .005"	Test .0152 amp. Readj. .0148 amp.	Test .0138 amp. Readj. .0142 amp.	
#208-C BO' and FO' Armature Gap .018" to .021" inch Contact Gap .004" to .005"	Through relay. Test .0122 amp. Readj. .0118 amp. Through BO' and FO' relays in parallel Test .0244 amp. Readj. .0236 amp.	Through relay. Test .0108 amp. Readj. .0112 amp. Through BO' and FO' relays in parallel Test .0216 amp. Readj. .0224 amp.	

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CHK'D.--CHW.

APPROVED-C.L.SLUYTER, G.M.L.